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THE TEA RESEARCH INSTITUTE

St. Coombs, Talawakelle,

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*THE ROLE OF GREEN MANURING IN THE MAINTENANCE OF THE FERTILITY OF TEA SOILS.

By

G. B. Portsmouth

In a recent talk given to a number of District Planters' Associations, which is being published in the *Tea Quarterly* (1) Mr. Lamb dealt with the general problem of the maintenance of fertility in tea soils. In my talk today I propose to try and go on from where he left off and deal more specifically with the contribution made by green manuring to the maintenance of our soil fertility.

Most of you are undoubtedly familiar with the very high degree of fertility that is, in general, originally exhibited by jungle new clearings. Furthermore, there would appear to be some considerable degree of correlation between the length of time that the cleared area has been under its original stand of jungle and the level of fertility found on opening up. This is not entirely a chance effect but is in fact a real indication that tropical rain forest conditions, which are the conditions under which our wet zone jungles all develop, do lead to a continuous building up of soil fertility. Once, however, such cleared land is utilised for growing crops, a marked change usually sets in and, instead of finding our soil fertility increasing, we find that there is a tendency for it to decline. It is accordingly much of the purpose of what is normally called good agricultural practice to arrest this potential decline and to enhance or maintain our initial fertility level. Before therefore attempting to lay down a code of good agricultural practice for our own particular crop, which in this case is tea, let us try and see in what way jungle conditions differ from those under which tea is grown as an economic crop.

A tropical rain forest, as the jungle is more correctly called, is essentially an ecological unit. This means that although there are a vast number of different species growing together in the jungle, they form a more or less closely knitted community in which each plant species has its particular place and function. In essence our tropical rain forests consist of a number of layers. The first or lower layer consists of shade loving ground plants, bushes and small trees ; none of which attain any great size. Above this lower layer are the jungle trees proper which form the actual forest canopy. Both these layers are of course initmately knitted together by climbing plants and creepers in enormous variety. Finally, standing out above the general level we have the isolated big trees, mainly dipterocarps, of which Shorea, one of our timber trees, is a typical example.

This is admittedly a very incomplete description of a tropical rain forest, but the fact to which I want to draw your attention is that we do have a complete canopy of vegetation covering the ground ; in actual fact a very dense canopy made up of several layers. This has two effects. Firstly, almost no sunlight penetrates through the canopy and reaches the soil beneath, and secondly, heavy rain is intercepted by the canopy and can not beat down directly on the soil below. However, I think the most important difference between tea estates and jungle conditions is that the whole of the leaf fall from this dense mass of jungle vegetation remains on the area. It is this large amount of leaf fall which helps to make our jungle soils.

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* *Lecture delivered to Southern Province Planters' Association on* 28-6-51.

Summing up, therefore, soil fertility is built up under jungle conditions because :—

(i.) The vast amount of vegetable material produced in the area remains there and goes to form the rich layer of soil on the jungle floor, and,

(ii.) This is protected by the forest canopy from the deleterious effects of exposure to sunlight and to the weathering action of heavy rainfall.

Finally, not only is the whole of the organic matter produced kept on the site, in contrast to the vast amount removed as crop from tea estates, but no mineral nutrients are removed either. Mineral nutrients are of course removed in large quantities in the crop from tea estates but,as these can be easily replaced by fertiliser applications, I do not propose to deal with them further today.

Accordingly, in order to maintain a high level of soil fertility the aim would appear to be to approach as closely as possible to jungle conditions in our agricultural practices. These conditions must, however, be such that high yields of the particular economic product we are growing can also be obtained. Fortunately, tea itself was originally a jungle plant and its actual home appears to be in the jungles of North India and Burma where it apparently grows beneath a canopy of Albizzia type forest. There is thus nothing inconsistent with the possibility of obtaining high yields if we attempt to make our agricultural conditions approach to those of tropical rain forests. This then should be the object of a properly organised green manure policy on an estate. Here, of course, I include under the term green manure all vegetation normally grown on a tea estate, that is to say high and medium shade, bush green manures and ground covers.

Now all these green manures have to be grown interspersed with the tea and it is therefore important that we select satisfactory species which do not become liable to compete unduly with the tea and which will grow well under our particular climatic conditions. Fortunately, many plants of the *Leguminoseae* possess root nodules which contain bacteria capable of fixing atmospheric nitrogen. These plants are therefore self-supporting to a great extent as far as nitrogen requirements are concerned and this valuable property naturally makes them a first choice as green manure plants. Even leguminous green manures, however, require quantities of the other two main plant foods, phosphoric acid and potash, and it is accordingly desirable in selecting suitable species to attempt to reduce competition for these two nutrients to a minimum. This object can be achieved, for example in the case of high and medium shade trees, by planting species which develop deep penetrating roots which reach levels of the soil far below that in which the main bulk of the tea bush roots are feeding. The establishment of such deep rooting species has also the additional advantage that, once their roots get well down, they will be exploring new layers of soil from which fresh supplies of plant food are brought up and returned to the top layers of the soil, where they become available to the tea, in the shape of leaf fall or loppings.

Once a satisfactory stand of shade trees and green manures has been established there is, I think, little cause to worry about their requirements of plant food, since all nutrients taken up will be eventually returned to the soil again as leaf fall or loppings. Once this type of closed cycle has been successfully established for our green manures all we need concern ourselves about is in returning to the soil the plant food removed in our crop. However, it must be borne in mind that, when establishing a new stand of shade or green manures, some plant food is likely to be required and provision should be made in your estimates for the necessary fertilisers, otherwise the tea is liable to suffer temporarily.

Finally, before passing on to more particular recommendations about different types of shade, I would like to say just a few words regarding the enormous importance of organic matter in the soil. Under tropical conditions, organic matter is destroyed very rapidly and, unless a basic level is maintained, it is quite impossible for a healthy population of soil micro-organisms to exist or for a reasonable soil structure to be maintained. Organic matter, originally supplied in the shape of leaf fall or loppings, is turned into humus by all the multitudes of micro-organisms

which live upon it and it is this humus which plays an essential part in binding the soil particles together and so producing crumb structure. Without some reasonable degree of soil structure, there is no aeration nor does the soil drain properly, with the consequence that plant growth can not proceed satisfactorily and only poor crops will be obtained even with heavy applications of inorganic fertilisers. Organic matter is most quickly destroyed under conditions of exposure and insolation and it is accordingly most important that we should not allow soils to remain bare for any considerable length of time. This is a very valuable point to keep in mind when new clearings or replanting work is undertaken ; that a great deal of our soil fertility can be destroyed by a few months' exposure of bare soil to the action of hot tropical sun and rain. So, therefore, if you are clearing old rubber land for the purpose of planting up in tea, make every effort to maintain existing soil covers as long as possible. For the same reason, the establishment of a new canopy of high and medium shade and bush green manures and ground covers should be carried out at the first opportunity on any new clearing.

Before I offer any comments on the types of shade and green manure plants normally grown on estates, I think I better try and give you a brief outline of what appear to me to be the desirable qualities to be looked for in these plants. These would seem to be :—

(i.) The ability to supply a large amount of organic matter either in the form of loppings or leaf fall. This requirement is perhaps not so essential in the case of ground covers.

(ii.) The ability to provide a suitable degree of protection, both to the soil and to the tea plants growing on it, from the effects of driving rain, sunlight and wind.

(iii.) The ability to grow easily under the particular climatic or elevation conditions encountered. In what follows, therefore, I shall attempt to confine my remarks to species which should be suitable for growing under low-country conditions.

(iv.) The plants must not compete unduly with the tea bushes for either plant food or light and air.

(v.) They must not be unduly susceptible to pests and diseases.

High and Medium Shade Trees

I think the best species are probably the dadap, the Gliricidia, the various species of Albizzia and the Grevillea. With the exception of the Grevillea, which belongs to the *Proteaceae*, all these trees belong to the *Leguminoseae* and are nitrogenous. In spite of it being non-nitrogenous, however, the Grevillea is probably one of the most widely used types of high shade in Ceylon and it does not seem to compete unduly with the tea because it would appear to be usually fairly deep rooted. This is a most valuable feature which enables it to bring up considerable supplies of plant food from the deeper layers of the sub-soil. This penetrating action of any deep rooting shade is also very valuable in breaking up the sub-soil and so enabling the shy-rooting tea bush to put its roots further down. The chief drawback of the Grevillea in the low-country would appear to be its susceptibility to the Phyllosticta leaf disease. This disease can be controlled to some extent by pollarding the Grevilleas at frequent intervals. Albizzias grow very fast in the low-country and this tends to be rather a drawback because they soon get too big and have to be removed. Otherwise, they provide excellent quantities of lopping material. In certain areas wood boring and bark eating caterpillars of the genus *Arbela* may cause a certain amount of trouble. The dadap is, of course, an excellent medium shade tree at almost all elevations but its susceptibility to the root knot eelworm may cause trouble in growing this species in areas where eelworms are prevalent. Various species of *Derris* often appear to grow well under low-country conditions but I think this genus is somewhat undesirable owing to the readiness with which it produces root suckers. Another species worth trying appears to be *Dalbergia Assamica.* This name is actually incorrect but is the one by which the species appears to be known in Ceylon.

Bush Green Manures

In this category, the best species are probably the familiar boga (*Tephrosia candida*) and the various Crotalarias. Several species of Crotalarias are likely to do quite well under low country conditions, but *Crotalaria usaramoensis*, is probably one of the best. Incidentally, you may be interested to know that I found a species of Crotalaria—*Crotalaria retusa*—growing freely on the top of Sigiriya rock. It is a comparatively low growing species and might be well worth a trial as a type of bush ground cover in new clearings. *Desmodium gyroides* is another plant which also appears to do quite well in the low-country. All these are nitrogenous plants belonging to the family *Leguminoseae.*

Ground Covers

The choice of a suitable ground cover is probably one of the most difficult things confronting us in regard to green manuring. A very large number of species have been tried out but in nearly all cases they show various disadvantages, thus they may climb into the tea bushes or form too dense a mat for a fork to be put through in manuring operations. Today, I only propose to refer to two types. The first is *Desmodium ovalifolium.* Experiments, using this species for a ground cover, have now been in progress on Enselwatte Group, Deniyaya, for the past six or seven years. Two similar fields were taken and one was planted up with *Desmodium ovalifolium* while the other field was left uncovered. Uptodate, yields have been consistently increasing in the field with Desmodium cover as compared with the uncovered field, and are now something like 100 lbs./acre per annum ahead. I am very glad to say that the Superintendent of Enselwatte, Mr. Fernando, has written an article on his experiments which will be published in a forthcoming *Tea Quarterly* (2). Provided that he is given due notice, Mr. Fernando will, I am sure, be only too pleased to show anybody interested round this experiment.

The second genus to which I am going to refer is *Stylosanthes*, of which two species (*S. gracilis* and *S. mucronata*) were obtained from Peradeniya a short while ago. The plants are rather like a type of lucerne and spread very readily over the ground but do not root at the nodes. Accordingly, they produce a mat which can easily be rolled back for manuring or other cultivation purposes. They are now being grown experimentally on a number of estates and such reports as we have received to date are most encouraging. They are, I think, probably well worth a trial. All the species I have referred to are again, of course, members of the *Leguminoseae.*

Whilst on the subject of ground covers, I think it is worth while for me to point out that with the short pruning cycle customary in the low-country, there is very much more ground exposure during and after pruning than is the case in the up-country tea districts. For this reason, therefore, it seems to me most important that attention should be given to the subject of ground covers in the low-country.

Poor Areas

Before finally concluding, I would like to make just a few remarks about poor areas. In many cases it is becoming increasingly apparent that the inability of poor areas of tea to respond to improvements in fertiliser application and better cultivation methods may be ascribed to the complete lack, or perhaps I had better say, shortage of organic matter in the soil. Rehabilitation of these poor areas is accordingly only possible if the organic matter level is restored to something like a normal figure. Green manures themselves will only grow very badly in these poor areas and so it is quite impossible to expect the stand of green manure in a poor area to be sufficient to produce the required amount of organic matter since, to achieve any lasting results, application rates must be of the order of 20 tons to the acre. Here then is a case in which organic matter must be brought into the field from outside. Where estates have spare land available, the production of the necessary green material is comparatively simple. Grasses such as Gautemala or Napier, if properly manured, are likely to produce the heaviest crop of green material possible per acre and are capable of giving several cuts in the year. After lopping

the grass will probably be best utilised as a thatch rather than being dug in green or turned into compost. Sunflower is another valuable green manure plant which can be grown in ravines and waste places and provides a large amount of soft green loppings. These should however be forked in green rather than used as a thatch, otherwise considerable wastage will result. Compost and cattle dung, etc., are, of course, equally good sources of organic material for rehabilitation purposes. However, on most estates they are unlikely to be available in anything like the quantities necessary for this work and it is therefore obviously desirable to concentrate on the cultivation of grasses and other high yielding sources of green material. Grasses must not, of course, on any account be grown in the tea.

Finally, I must confess that we still have a very great deal to learn about the principles of green manuring and what are the best types of green manures to grow in the low-country. As you probably have now heard, we have just taken over Pembroke bungalow, approximately four miles from Kalutara, as a headquarters for Mr. Walter, our Low-country Scientific Officer. In due course, when he gets settled in, I am hoping it will be possible for him to try out a number of different green manures at Pembroke. In the meantime, we shall be grateful for any information that can be given to us regarding different green manures which have been tried out successfully on low-country estates.

References

(1.) Lamb, J.—The Maintenance of Fertility in Tea Soils. *Tea Quarterly*, XXII, Pt. II, pp. 45, 1951.

(2.) Fernando, T. M.—*Desmodium ovalifolium* as a Cover Crop for Tea. *ibid*, pp. 49.

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*THE WEED PROBLEM ON TEA ESTATES

By

G. B. Portsmouth

At the outset I should like to say that when your Chairman invited me to talk to you today, he was very insistent that the subject should be that of weeds. No doubt this is a subject of considerable interest to most of you but it is also one, I must confess, about which we have little definite information to offer. Accordingly, I do not propose to give you any formal talk but rather to touch on such aspects of the weed problem as may provide food for thought and subsequent discussion.

Firstly, I think there is little room for doubt that the problem of weeds has been coming increasingly to the fore in many up-country districts in the past few years. As I have felt and said before, this increase in weed incidence is to my mind entirely the result of a decrease in the vigour of our bushes and is in no way concerned with the virulence of the weeds themselves. Hard pruning in the past, coupled with blister blight over the last five years has undoubtedly, reduced the size of many of our up-country bushes and thereby allowed more exposed soil to be available for the growth of weeds. With an increasing area of our fields covered by weeds the competition has naturally increased and has again reacted on the vigour of our bushes. If not stopped in time, this situation has obviously the makings of a vicious circle. However, I am glad to say that the outlook for the future is nothing like so gloomy as my previous remarks may have led you to suppose. We have now, I feel fairly confident in saying, got the ravages of blister blight well in check by the crop protection measures which have been introduced by the Tea Research Institute. Furthermore, the adoption of the much lighter style of pruning which we have been

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* *Lecture delivered to Dickoya District Planters' Association on* 30-7-51.

recommending for some years past, is now beginning to show results in improved spread of our bushes. Provided, therefore, that this lighter pruning is persisted with and the bushes are efficiently protected from blister blight during their recovery period, I see no reason why we should not soon develop a fairly good cover of tea over most of our fields. Once a satisfactory cover has been restored, then, I feel certain, the problem of weeds will be reduced to almost negligible proportions.

However, even though an improved cover of tea does successfully crowd out weeds during the succeeding years of the cycle, it may well be expected that weeds will constitute a considerable problem during the first year of the cycle for many years to come. Owing to the heavy weed growth that has been developing in the past, there are undoubtedly millions and millions of weed seeds still viable in the soil. Given suitable conditions to germinate, such as those following pruning, these may be expected to come up in very large numbers. Obviously, therefore, it is important that efficient weed control measures should be carried out during the first year of the cycle so that the weeds are prevented from seeding and perpetuating the problem. Once the numbers of weed seeds in the soil are reduced to a comparatively low level, then I see no reason to expect that, provided they are efficiently controlled, weeds should constitute a problem at any stage in the cycle. Fortunately, there is a very simple solution to this particular aspect of our weed problem and this is to thatch immediately after pruning. Thatching will not only keep our weeds in check but it will also serve the equally valuable purpose of protecting our otherwise bare soil from the evil effects of heavy rain and insolation.

In the meantime, how are we going to deal with our existing weeds ? At the present time, there is, I am a afraid, still no easy solution to this problem and we must, therefore, still continue to deal with our weeds in the hard way. None of the weed killers of which we have completed tests to-date can be safely recommended for use in mature tea. However, we are at present experimenting with a new weed killer known as sodium trichloracetate, which is alleged to be reasonably selective for monocotyledonous plants such as grasses. If these claims are borne out in practice, then there is some possibility that this could be used for the destruction of grasses and other monocotyledonous weeds in standing tea. At the moment, owing to prevailing weather conditions, it has not been possible to carry out extensive tests with this substance and all I can tell you at the present is that it does at least appear to be very effective against mosses and ferns. This problem of dealing with weeds is likely to be still more complicated in the near future since, under the new Soil Conservation Act, Parliament has empowered the Director of Agriculture to make regulations prohibiting clean weeding in scheduled areas.

In any satisfactory system of weed management, there are two factors which must be taken into account. These are :-

(i.) The weeds themselves absorb a considerable amount of plant food which should on no account be removed from our tea fields and

(ii.) No weeds should be returned to the field unless all viable seeds have been destroyed or else disposed of in such a way that they are subsequently unable to germinate.

In practice, there would appear to be only two satisfactory ways of meeting the above requirements :—

(i.) By collecting the weeds and composting them off the fields. This is a process which has to be done carefully if all the weed seeds are to be destroyed and any nutrient loss avoided. Composting must be done under cover to avoid loss of valuable nutrients such as potash, due to leaching by rain, and care must also be taken to see that the weed piles heat up efficiently and the process of decomposition really gets going. This can probably be assisted by the use of a little extra sulphate of ammonia between the layers. Once it has been properly made

compost is, of course, completely safe and can be put in, in the normal way, behind the fork. However, I would like to emphasise at, this point, that composting is only recommended in the case of weeds in order to kill all weed seeds, since, however well done, there is a very large loss of organic matter during the composting process which is thus extremely wasteful.

(ii.) The second method of disposal of weed is, of course, to bury them green in pits in the fields. This again has to be done with care since the weeds must be buried at a sufficient depth so as not to be disturbed by subsequent cultivation operations and brought up to the surface when viable seeds will, of course, germinate. Accordingly, it would seem advisable that the topmost layer of weeds in a pit should be at least 18" below the surface. This method again has considerable disadvantages, since weeds buried at this depth are unlikely to become directly available in the form of plant food to the tea bushes themselves. However, we have at least carried out the ideal agricultural practice of returning all our organic matter to the soil and it may be supposed that we shall get some future benefit through the medium of shade trees or bush green manure growth.

Another method of dealing with the weed problem is, of course, selective weeding. Many of you have probably tried it and I shall be very glad to hear either in the discussion which may follow this talk or if you would write in to us at St. Coombs, what results any of you have obtained. Our own experience with selective weeding on St. Coombs is extremely disappointing. Some years ago the policy of leaving *Polygonum nepalense* on a number of fields was adopted. This policy has now had to be abandoned, within about the last year or so, owing to the enormous spread of the Polygonum, which started climbing up into the tea bushes and altogether got completely out of hand. As a result it is now being ruthlessly exterminated. This weed is one which seeds very freely and, when left without competition from other weeds, the number of seeds produced increased so enormously that it proved quite impossible to control the plants by slashing or any other form of treatment. So far, therefore, our attempts to adopt the selective weeding policy have proved a failure. This, however, does not necessarily mean that all selective weeding policies will be failures, since I feel fairly certain that the success or otherwise of selective weeding does depend to a great extent on the plant chosen to be left. *Polygonum nepalense* obviously is not a suitable plant under the conditions prevailing on St. Coombs.

Now a few words about the nutrient requirement and manurial responses given by weeds. The actual composition of a crop of weeds is, of course, very variable but average figures obtained by Dr. Eden (1) indicate that the proportion of potash is extremely high ; thus analysis of a 3½ months old crop of weeds on St. Coombs gave the following figures :—

Nitrogen	—	1.89%	
Phosphoric Acid	—	0.85%	and
Potash	—	3.46%	

There would thus appear to be approximately twice as much potash as nitrogen removed by a crop of weeds. This is rather serious at the present time considering the somewhat poor potash status of most of our fields. In particular, therefore, I would again like to emphasise the importance of protecting compost heaps from the action of weather, since if exposed to rain, almost all the potash in the weed crop will be leached out and lost.

Despite, however, their very high potash content, weed growth appears to respond primarily to phosphoric acid manuring rather than to that of potash or nitrogen. This response to phosphoric acid is extremely marked and on all the T.R.I. manurial experiments, when growth is in evidence, it is easy to pick out the different phosphoric acid treatments purely by visual differences in weed growth. Accordingly, if anybody wants to increase the amount of weeds on their estate all they need do is step up their phosphoric acid manuring. Unfortunately, I am

afraid, I cannot tell you what to do in order to reduce the weed growth. An interresting example of the effects of phosphoric acid manuring is given by our Passara Manurial Experiment, where increased doses of phosphoric acid have failed to give any increased yields of tea and have in fact produced rather less owing to the enormous increase in weed growth which has occured. There is thus considerable evidence that excessive weed growth does have a marked competitive effect on the tea bush. This Passara Manurial Experiment is also interesting in showing an interaction between phosphate and potash in regard to weed growth. With increased phosphate manuring an equivalent increase in potash increases the amount of weed growth fivefold. With excess phosphate applications, therefore, there would appear to be considerable danger of a great deal of our potash manuring merely going to increase weed growth.

Finally, as you know, we are all very concerned at the amount of deterioration which would appear to take place when bare soil is left exposed for considerable periods. Looking at things from the long term point of view, it is possible to argue that the existence of a crop of weeds on what would otherwise be bare soil may be rather more beneficial than otherwise. However, I think it is quite impossible that we can expect good yields of tea under these conditions and it therefore raises the problem as to whether we sould aim at crop now or whether we should preserve our soil for future development. Thatching after pruning will help us considerably but I have serious doubts as to whether many estates will be able to produce enough thatching material to cover their pruned fields, let alone their older fields. Accordingly, I must once again remind you of the old adage that ' the best cover for tea is tea ' and urge you once more to do all you can to increase the spread of your bushes and so crowd out your weeds, whilst at the same time protecting your soil from erosion and deterioration.

Reference

(1.) Eden, T.—Monographs on Tea Production in Ceylon, No. 1,p.39, 1949.

COMPOST

By

F. Haworth

It is evident, from the large number of enquiries received recently, that there is still much time and money being wasted on estates in preparing compost. The subject is fully dealt with by Eden (1) and there is very little more to add to what appears in that reference.

However, the present policy of the Institute in this matter should be defined.

First of all let it be stated that the value of really well made compost is beyond dispute by anyone ; whether it is an economic proposition to prepare such a material is another question.

At its best the composting process is wasteful, for at least 50% of the organic matter originally put into the heaps is destroyed and lost during rotting. Nutrients such as nitrogen, phosphorus, potassium, etc., can be supplied to the soil in satisfactory form as inorganic manures but, to maintain a healthy soil, humus is necessary. This can only be supplied from plant sources. Hence, having grown a large crop of organic material, it is manifestly wasteful to throw half of that potential humus away by turning the organic residues into compost.

It is true that the addition of materials of high carbon-nitrogen ratio to the soil can easily lead to temporary nitrogen starvation of the growing crop, due to the using up of the available mineralized nitrogen by the decomposing organic material. Against this must be set the fact that a small dose of sulphate of ammonia applied before, or at the same time as the organic residues, will prevent any possible temporary nitrogen deficiency and will also assist in breaking down the organic matter.

Another point, frequently lost sight of, is that soil organic matter is probably of greatest value, both in building soil structure and supplying plant nutrients, when it is actively decomposing. Hence it would seem reasonable to carry out the composting process in the soil itself so that the full benefit is derived from the organic residues available.

What then is the place of compost on the average estate ?

On all estates there are waste materials of many kinds which are not suitable for direct incorporation into the soil or which would be obnoxious if applied untreated. Materials such as line refuse, weeds, etc., are the most common waste products. Such materials must be dealt with in some way before applying them to the soil and composting is probably the best treatment.

All other materials, green manure loppings (grown either in the tea or outside) and grasses of various kinds should be applied direct. In the case of the latter, care should be taken to apply these materials together with or shortly after an application of inorganic manure to avoid possible temporary nitrogen starvation of the tea.

It must be realized that composting should be used as a means of disposing of waste materials and not as an end unto itself. It is one part of the whole programme of the preservation and improvement of the organic matter status of the soil.

The place of composting on estates having been defined, the question of how to make compost properly is often asked. More has been written on this subject that the writer cares to recall but the notes given at the end of this article should help to produce a reasonably satisfactory product. Having made the compost it remains only to apply it in the field.

As a result of recent detailed investigations on St. Coombs into the root system of the tea bush, it seems highly likely that to dig holes or pits between the rows in healthy tea must result in considerable damage, not only to the feeding roots of the tea bush, but to many permanent roots in addition. Therefore it would appear that careful forking is possibly the best method of getting the compost into the soil. On many estates the burying of prunings and compost in pits has been carried on for many years and examination of cross-sections of the soil in these areas indicates that there are very few permanent roots in the top 12″ of soil. Hence the damage due to burying compost in pits in such cases may be very much reduced.

The rate of application is also the subject of frequent questions. Eden (1) quotes an experiment on St. Coombs where 4 annual applications of 15 tons per acre of Adco compost gave a yield response lasting for nine years. Smaller annual doses are unlikely to have any material effect. In this connection it should be remembered that a soil having 5% of organic matter in the top 9″ of soil contains 50 tons of organic matter per acre. 15 tons of really good compost probably contains only 6-7 tons of organic matter.

Most estates will find great difficulty in producing sufficient compost to treat more than very small areas and in general compost is best used in working up poor areas of tea. Another rather specialized use of compost is in minimising the effect of eelworm attacks in infected areas.

Those eelworms which are parasitic on tea have certain natural enemies such as predatory eelworms and parasitic fungi. These enemies are encouraged by a high content of organic matter in the soil and under such conditions they tend to keep the population of harmful eelworms within reasonable limits.

This indirect control of parasitic eelworms by building up a high organic matter status in the soil, is of considerable importance since at the present it is the only control method which can be applied in the presence of a growing crop.

It is hoped that this short statement of the Institute's views on this controversial subject will help to clarify many of the questions which caused this article to be written.

Notes On Compost Making

1. The materials used should be as fresh (green) as possible.

2. The heaps should be covered to prevent leaching of nutrients by heavy rain.

3. Heaps are made as follows :—

(*a*) A layer of vegetable matter about 1 ft. thick and say 4 ft. wide is laid down (The length of the heap is immaterial).

(*b*) Next is added either a layer of cattle manure 3″ thick or sulphate of ammonia at the rate of ½ ounce per square yard.

(*c*) Another 1 ft. layer of vegetable matter.

(*d*) Another treatment with cattle manure, or sulphate of ammonia.

This is repeated until the pile is of sufficient height.
N.B.—The vegetable layers should be as loose as possible to promote rapid heating and breakdown. A temperature of about 130° - 140°F (60°C) should be attained after about five days.

4. After 4-6 weeks, whilst the heap is still warm in the middle, it should be turned into a new heap, putting the outside of the old heap to the middle of the new one. In this turning the aim should be to get as much air into the heap as possible.

The compost should be ready in a total time of 3-4 months. If it is not, it is usually a sign that it has not been made properly.

5. In dry weather it is essential for the heap to be kept moist but not wet.

Reference

(1.) Eden, T.—Monographs on Tea Production in Ceylon, No. 1, Chapter 6, pp. 52, 1949.

ON THE USE OF COIR DUST IN MANURE MIXTURES.

By

F. Haworth

Some time ago a suggestion was made at a meeting of the Estate and Experimental Sub-Committee of the Tea Research Institute (by Mr. G. K. Newton) that coir dust might be useful as a means of increasing the bulk of inorganic manure mixtures.

Such an increase in bulk would facilitate the distribution of the relatively small doses of fertilisers which it is sometimes desired to apply. It was found that the addition of some 10% by weight of coir dust to an inorganic manure mixture caused a doubling of the bulk of the mixture.

Accordingly, to a mixture of sulphate of ammonia, saphos phosphate and muriate of potash, was added 10% by weight of coir dust. The mixture was forwarded by rail and road to St. Coombs in the normal way.

On arrival the bags were laid flat and samples for analysis were withdrawn from various parts of each bag through slits cut in the fabric. The slits were then closed and the bags were stored upright for 3 months. Further samples were then withdrawn and analysed.

The results showed that the inorganic manure was evenly distributed throughout the mixture and that there was no tendency for the inorganic components to separate during transit and storage.

The physical condition of the mixture was excellent and remained so after storage for 3 months.

The Superintendent reported that the mixture handled very well and that the additional bulk facilitated distribution in the field. He also commented on the fact that it was easier to see where the manure had been applied and hence supervision of distribution may also be assisted.

Against these advantages must be placed the additional cost of bags for the more bulky mixture and increased transport charges. Coir dust itself has virtually no manurial value but it is cheap and available.

It is considered that it may prove useful as a means of increasing the bulk of inorganic manure mixtures in cases where it is necessary to apply small amounts (up to 2 cwt. per acre) of inorganic manure.

We are indebted to Messrs. Shaw Wallace & Co., Ltd. for preparing the mixture for us.

*REPLANTING TEA.

By

A. C. Tutein Nolthenius

(*Received 19th June, 1951*).

Whilst some of the opinions expressed in this article appear to be somewhat at variance with those of the Institute, the main theme, namely the importance of instituting a regular programme of replanting, coupled with attention to soil improvement, cannot be too strongly endorsed.

Many of our tea soils are very poor in organic matter and it is probably this fact which has led the author to express doubts about the effectiveness of heavy fertiliser applications. Once, however, the organic status of these soils has been improved by bringing in soil building material from outside, as is suggested in the section on "Resting-cum-Replanting", then there is little doubt that the bushes will respond satisfactorily to suitable doses of properly balanced fertilisers. As long as yields continue to increase proportionately, there is no reason to suppose that increasing fertiliser applications will ever become uneconomic.

Selected vegetatively propagated plants are, of course, capable of giving much higher average yields than plants grown from Ceylon seed and several of the St. Coombs clones show yield potentialities of over 2,000 lbs. per acre.

Camelia Thea Link

Like all living things *Camellia Thea*, a jungle tree from the wilds of Central Asia, has got an age or lifelimit. This limit has not been ascertained but it is thought to be some 100 — 150 years. It is likely that this exotic tree, which we know as the cultivated teabush, will have had the lifelimit shortened by the artificial treatment it receives in unnatural surroundings.

True types of Camellia species, like Bohea, etc., are not found in Ceylon. Our tea is the offspring of multiple hybrids. These hybrids have their value because through the years they have adapted themselves to the many peculiarities of local climates and conditions.

The lifelimit means death and before this stage is reached the recognised and logical solution — usual for all perennial crops and modern forestry — is to uproot and replant ; to start all over again. Rubber is one of the many examples and it will be remembered when this problem was much argued and debated. The same problem now faces our tea.

Ceylon Tea

Some 70 — 80 years old tea is still in production, an example of the splendid stamina Camellia has got. Without any destructive criticism nor uncalled for alarm we must realise and admit that much of the Ceylon tea is now of middle-age and over. Output must therefore decline.

Artificial stimulation is desirable for all crops but if it had not been for the constant and excessive exciting of much exhausted and impoverished soils the island's yield today would show a smaller return than it does already.

Quality before quantity always paid and paid well but, when the quantity decreases beyond repair, due to old age which we cannot control nor remedy, quality alone is no longer of value. The position becomes serious and demands early understanding and careful revision. The lifelimit cannot be ignored and it must be clear that the replanting of old tea must be accepted sooner or later as a

** The Institute does not necessarily endorse the views expressed in papers contributed by persons other than members of the Staff.*

quite natural revenue item in future estimates and expenditure, exactly the same as we provide for the uprooting and replanting of shade and green manure trees on a rotational programme. Prominence must be given — this seems most necessary—to the fact that " replanting for upkeep " will come to stay and will be one more of the many essentials our heavily burdened tea has to face.

There is need for general, public and Government interest in replanting, otherwise disappointments will be many because of casual disbelief and halfhearted attempts. Government help and support may be required. Ceylon depends on its tea ; the country's future is at stake.

Replanting for upkeep is a natural fact. Replanting to try and get more-fold returns is a different matter. It should be possible to increase, perhaps even duplicate our crops. Could we triplicate them.....who would buy our teas ?

Yield

The accepted yield for tea is the intake in pounds of made tea per unit of area, which is as a rule one acre. In practice this means of expressing yield is often somewhat misleading but it seems impossible to design a better or more accurate method. It suits what we know as young tea. It is with middle-aged and old tea where we go wrong or get muddled. Here the crop is no longer taken from all the teabushes per unit. It comes perhaps from 60 — 65%, often less, of the total number of bushes per acre. Taking the present planting-stand, old methods, at 3000 this means that a 600 lbs. made tea yield is produced by some 1800 to 2000 bushes. The rest of the bushes are expensive passengers or unemployed on the dole. We pay that dole.

If all the bushes pulled their weight that same unit of land could produce some 1000 lbs. made tea or more per acre. Taking the cost per acre for a 600 lbs. yield today at Rs. 900/-, if that unit had given the full return the cost would have been reduced to some Rs. 600/- per acre.

In a more or less degree the above will apply to all cultivated tea over a certain age, at any rate under the conditions we know and accept in Ceylon. Too much reliance is often placed on the " acreage of tea in bearing ". That may look well on paper but it is luxurious if we remember the dole. The deciding and principle factors are the cost per acre and the return per acre. Anything we can do to increase the difference must be our aim, must receive continued study and research, and must be taken as our first essential.

Perhaps the simplest way out would be to forget the passengers or to dismiss the unemployed. In practice this is not possible. No matter what their value or their use in the scheme of things all the bushes per acre are weeded, all are pruned, mossed and manured, all are or will be sprayed, and too many will be tipped and their last energy taken.

We must also accept the fact that the producing bushes are nearing the lifelimit and may loose the power to yield or reach the yield-limit even sooner. Once reached, the yield-limit can not be increased nor can it be maintained for long. It will decrease by the laws of nature until another bush joins the unemployed or goes on to the deathroll. Because of the hybrid nature of our planting material, and no two tea bushes being alike, this natural process must be uneven. This is happening today.

Not only old age and nature but we ourselves are hastening the yield-limit by stripping for crop, atomic manuring, never resting, and other mistakes.

Appearance

" The tea looks in good heart ", whatever that slogan meant it must have pleased proprietors and Company directors. Appearance is often mentioned, perhaps quite naturally, but why is it that the appearance of tea is all too often found misleading ? Tea which looks like 700 lbs. gives 500 lbs. according to the records, while poor tea sometimes gives unbelievable yields. Of course one must presume that the acreage figures are true and correct.

Whatever the appearance, speaking in general of the tea districts in Ceylon, we reluctantly admit that the writing has been on the wall for some years. Our tea has gone back and old age deterioration shows its indisputable signs. For some years we did not like to believe this. We remembered the war years, the over-cropping as our national effort, the too little manure and the poor ingredients, the insufficient and inefficient supervision and so on. Of course all would come well as soon as conditions became normal. We forgot or ignored old age.

And strange to say all seemed well. Blister blight had come along, yields and export figures showed an increase no one could contradict. All were happy except a few who wondered if blister had not underlined the writing which we did not want to read.

Soil

One sometimes wonders if the manure-craze of recent years was not a curse in disguise. One cannot help asking what the general position of our tea might be today if part of the milliards spent on NPK had been made available, and had been allowed, for the crying needs of the horse flogged to death, the reconditioning of our soil.

Has it ever been proved if the seemingly excessive doses of nitrogen some threw out at 120 lbs. per acre, which even scientists are somewhat nervous of, ever gave a plus or a positive and tangible return ? Has it been proved, or examined if these well meant although perhaps somewhat suspicious intentions did not exhaust further the too small and meagre soil reserves and did not, or will in time to come, upset the balance of these inorganic sources, the balance of Nature? Is it impossible to over-manure ? Soil knowledge and chemistry, soil fauna and flora are little heard of in general practice. Soil analyses and other recognised standard methods are rarely applied.

During the last few years the evolution of old time ideas has come to the fore and general and better understanding is on the increase but — too few voices are crying in the dark to ears deafened by the rattling rupees pouring in from fantastic sale prices. The sense of proportion is easily lost !

Supplying

We were once taught and thought that anything which looked like a teaplant was good enough. Supplies came away nicely and were rarely heard of again. If they did not play the game it was of course not our methods, it was the weather and the worker who were to blame. Highly advertised tea seed became an amusing although ridiculous feature. The more costly the bigger the demand. Its origin, history or type did not matter. One purchased a name, it was tea seed and therefore good. But — there is no proved, no true to type, no tested and selected nor isolated garden tea seed in Ceylon. The import of foreign seed was prohibited at one time, perhaps rightly, although the latest methods of fumigation are simple and are definite. It will be difficult and will take many years to try and establish the much needed supply of pure-line seed for future needs.

Vegetative propagation came into its stride and has rightly been given prominence but, the many unknown factors of this easily obtained and inexpensive planting material must warn us to hasten slowly. Vegetative propagation is not clonal in the way the term is accepted for all grafting material, budded rubber, etc. The bud is not a cutting. Even budding has many risks and one cannot forget the thousands of acres of budded rubber, planted in a hurry, which were afterwards found to be of little value except perhaps for firewood. All had to be replanted a second time, using highly tested and proved clonal material or the progeny of isolated clonal seed.

Has budding tea been tried in Ceylon ? It might be a valuable and interesting experiment for future seed bearers.

Resting-Cum-Replanting

For middle aged and old tea in good soil, more so where funds may be a difficulty, it seems likely that proper resting may be an early and economical solution and may be better than deciding on the replanting of a large area. Such resting, not to be taken as the synonym of abandoning, will of course go hand in hand with all the essential attention and routine works required. Resting a certain percentage of a field or an estate will not reduce the total crop too much. Some of the decrease in crop should be made good by the better supervision and attention given to the tea in bearing. It is probable that good resting calls for at least one full cycle if not more and patience must not be grudged.

During the resting period the land will be planted with all and any shade and cover, the more jungly the better, suitably controlled. All and any soil building materials will be brought to the field from outside. It makes no sense to go to a great deal of trouble to take a lot out of the rested land and then to put back less.

When pruning before resting, priority and careful attention will be given to all passengers and doubtful cases and all such will be uprooted without any hesitation. This will not be too expensive and will do less harm than uprooting old tea over a large area and leaving it naked to the elements. It seems likely that the mechanical uprooting of tea on a large scale will do more general harm than is consistent with the advantages gained.

Replanting will follow modern ideas, close-planting with the best material, available, selected and reselected before it is passed as suitable. Highly selected quality stumps, perhaps only 5,000 or less per average maund of seed, for preference. If this is impossible, internodes from several selected mother bushes could be tried.

This chessboard planting, something like the keeper burning the moor, should result in invisible mending of a fairly decent old coat. For many estates this method should be within their means and in good time one can visualise the coming into being of complete new tea estates consisting of young tea of various ages. It would increase the old yield without the risk of losing quality. It will be gradual renovation and rejuvenation combined for estates which are not too close to the yield—and lifelimit.

Costs

The first thing would be to select the blocks or fields to be taken in hand. Worn out tea, bad soil patches useless for tea, and very steep slopes will be ignored. Far better to concentrate on a smaller acreage of good yielding tea than a larger " acreage of tea in bearing " which without the yield figure attached means nothing. When funds allow those areas can be put under timber, fuel, thatch and grazing. Our rainfall figures need specialized study and the enforced plantingof all wastelands, abandoned tea and so on may well come as a Gazette Ordinance surprise before long.

It is difficult if not impossible to try and arrive at any clear ideas of the cost of replanting old tea today or in the near future but, no doubt, one's own small experiments will indicate ways and means. Figures appear to range from Rs. 1,200 to anything up to Rs. 5,000 per acre. The last figure includes the most modern methods, such as platform planting, etc.

One of the most difficult problems will be to try and arrive at what should be the economical yield per acre for a certain estate, a group of estates, or even a district.

The essential thing is to make all concerned realise that replanting of old tea must be accepted as normal routine work if we are to try to make sure that we too can face the future with confidence.

Ceylon has about reached, in some cases perhaps over-stepped, the peak of high cost of production per pound of tea that the industry can bear. This is due not only to factors like wages, cost of living allowances, export duties and freight increases ; a dangerous and important factor and one which we may be able to control is the low and decreasing future yields.

If our foreign competitors are forced to raise their costs to our level and pay their workers better wages, then the position may not be so black as it might seem as long as we agree and get the Government to agree the positive essential of REPLANTING TEA FOR UPKEEP.

RELATION OF COARSE PLUCKING TO QUALITY OF MADE TEA.

By

E. L. Keegel

The present time seems to be appropriate for a realization of the importance of a high standard of plucking if Ceylon teas are to maintain their pre-war position in the world's markets. That good tea cannot be made from bad leaf is a dictum that is apparently ignored in planting circles today, if one is to go by the evidence collected in factory advisory work. It is discouraging to note that the knowledge acquired by research and experience all these many years is escaping the attention of many. No doubt the planter is beset by many difficulties, but there appears to be little justification for the production of stalky and fibrous teas. It would appear that one reason for this state of affairs is the plucker's strong disposition to remove all the leaf that her hands can get hold of. This practice started in the war years when the appearance and quality of made tea was of little importance. Still, it should not be a dificult matter to train the plucker to use her hands judiciously. The time wasted in the fields and factory compound in picking coarse leaf, an operation which it must be admitted removes only a fraction of undesirable leaf, might well be spent in selective plucking. There are some estates where the picking of coarse leaf even goes one stage further. Gangs of labourers are employed in the factory to pick over each batch of withered leaf before it is charged into the rollers and still very little is removed. Manufacture of such leaf then brings on a train of difficulties.

Claims are often made that the good results obtained in certain factories are mainly due to improved factory technique ; but, if the matter is deeply investigated, it will be found that the chief contributory cause is a good standard of leaf. It is difficult to spoil leaf except through gross carelessness and it is the writer's belief, based on results obtained from countless experiments carried out on St. Coombs, where practically every aspect of manufacture has been investigated, that variations in manufacturing technique make very slight alteration to the final product. Workers outside Ceylon also support the contention that within certain empirical limits the value of a tea is hardly affected by variations in conditions of manufacture. Obviously then, what matters most is the type of material handled.

That plucking is not being given the consideration it deserves is evident from the numerous enquiries received by the Institute on the subject of flaky teas, plain liquors and dull infusions. Visits to factories where these troubles occurred revealed that the condition was for the most part attributable to a poor standard of leaf. When a simple correction in the field would have achieved the desired results, much time and labour was expended instead in improvising new rolling programmes, altering withers and times of fermentation, but to little avail. There

have been instances where even machinery was blamed for poor results and it is not surprising that in such cases attempts to improve teas by changing the design of battens on roller tables have failed. The large measure of success achieved on estates where due attention is given to field operations emphasizes the advantages of good plucking.

It is not intended to lay the full blame on plucking for the falling standards in quality on many estates. Much can be done in the factory. The system of bulk buying in the war years has naturally led to a considerable lowering in the standard of manufacture. Those estates which sold their teas on contract were, of course, likely to be least concerned about manufacture. The return to freer trade with the re-opening of the London market will undoubtedly focus greater attention on this recently neglected branch of the industry ; but the fact remains that, unless there is a better realization of the influence of the standard of plucking on the made tea, there is little reason to hope that improvement in the methods of manufacture alone will raise the standard of quality.

To understand the significant bearing that coarse leaf has on quality, quite apart from its contribution to ' reds ' and fibre in the made tea and ' floaters ' in the cup, it may be as well to make first a brief reference to the chemical and physical composition of a tea shoot.

Dr. Evans (1) has shown that as ' tannin '* forms the major portion of the water soluble constituents it is without doubt one of the chief factors influencing quality. The range of variation of the ' tannin equivalent ' in the different parts of the shoot is shown in Table 1.

Table 1. *Values of the ' tannin equivalent ' in various parts of the tea shoot.*

Part of Shoot	' Tannin equivalent '
Bud and first leaf	20
Second leaf	14
Third leaf	13
Main leaves	11
Fish leaves	12
Stalk between 2nd and 3rd leaves	9
„ „ 3rd and main leaves	7
„ „ 4th and 5th leaves	4
Green stem	4
Hard stem	2

The effect of coarse plucking is very well illustrated by these figures and needs no elaboration. Considering that as leaf gets older the bigger it is in size it is not difficult to see why good teas cannot be made from a pluck with a preponderance of coarse leaf.

Dr. Tubbs, in his article on plucking standards (2), has provided more than sufficient information on the composition of crop harvested. In his own words he summarises the position as follows :—" A good plucking standard must be one in which the proportion of ' normal ' (two leaf) shoots is as high as possible, and, as an interim standard it is suggested that an average of at least 75 per cent by weight of two leaf shoots be sought ". How far estates are away from this rule of practical guidance will be seen from the figures (Table 2) obtained in an analysis of flush, which by present day standards would be considered normal.

* *More correctly the tea catechin complex*

Table 2. *Percentage composition of plucked leaf*

Two leaf shoots comprising bud and two leaves, and banji bud plus tender leaves	50%
Third leaves, single leaves, stalk and less tender banji	50%

These figures indicate how widely former recognized standards have been departed from and convey some idea of what would be the effect of coarse plucking on the composition of a pluck. The writer has come across instances where not more than one third of the crop brought to the factory could by any stretch of imagination be regarded as suitable for manufacture. Little wonder then that on most of the estates where plucking was bad profits were low and in some cases nil.

The question that naturally arises is whether to pluck for quality or for yield. As it is the overall profit that matters the answer must inevitably depend on the relation between prices secured and cost of production. On the abundant evidence available there is no question but that teas from coarse leaf realize lower prices in the market than those made from fine leaf. The main thing to be considered, therefore, is whether in the case of coarse plucking the extra crop compensates for the lower prices obtained. As far as experience goes, too fine a plucking standard is uneconomical. At the same time it is safe to say that the other extreme can be no asset as well. The question requires serious examination before a definite answer can be given and it is hoped that the matters now to be discussed will provide sufficient information on this vexed question.

There is a general belief, although there is little scientific evidence to back the belief, that low crops go with good quality and *vice versa*. There is nothing further from the truth than this statement. Selection work on St. Coombs has shown that some of the best high yielding clones have produced teas much above the average in quality. Then again there are estates where, by the application of well balanced manures in conjunction with sound cultivation and regular plucking rounds, not only are high yields obtained but good teas also made. In contrast it is not uncommon to find low yielding properties making the poorest teas. From this evidence alone the only inference that can be drawn is that it is the composition of the pluck which is the most important factor affecting the quality of the leaf.

That coarse leaf is associated with long plucking rounds no one will deny. It is well nigh impossible to get over-developed shoots with short rounds, unless of course healthy bushes are allowed to become high and what is not plucked on one occasion is taken for manufacture the next time harvesting is done. Bushes react in a similar way to a very forcing climate. These are exceptional circumstances which do not explain the increasing tendency on the part of many estates to pluck at long and irregular intervals. Many reasons are given, but they all centre round plucking costs. The policy apparently is to pluck as much as possible on each occasion and this can only be done by allowing longer intervals between pluckings. It is argued that in this way less labour is needed and yield increased. It may indeed be asked whether this is true.

Opinion is still divided on the relative merits of long and short plucking rounds in relation to yield. Unpublished work, carried out by the Plant Physiology Department over a considerable period of time on the effect of frequency of plucking on yield, throws some light on this disputable point. The experiment was primarily drawn up for the purpose of determining the influence of the length of round on the chemical composition of the flush. However, valuable data on yield were collected as well. The fresh weight of flush harvested from bushes of a high yielding clone, plucked at weekly and fortnightly intervals, was recorded. At each plucking all broken back material between the third leaf and one leaf above the fish leaf, whether tender or not, was also weighed. The results are set out below (Table 3) :—

Table 3. *Effect of weekly and fortnightly plucking on amount and composition of material harvested*

Plucking interval	7 days	14 days
	gms.	gms.
Weight of flush—(Bud and two leaves)	12,887	8,709
Weight of broken back material	2,233	3,740
Total	15,120	12,449

The figures given above are the totals obtained after 88 pluckings for the weekly round and 44 for the fortnightly. That crop is reduced considerably by the longer round is indicated quite clearly by these results.

Without entering into any controversy the results of another experiment (3) carried out on St. Coombs on the effect of plucking on a fourteen day round as against a seven day round may be cited. The difference in yield over a period of forty eight weeks was in favour of the shorter round and highly significant. There is one aspect of this experiment which calls for emphasis. The standard of fineness of plucking was the same for both treatments and was attained by a large amount of breaking back and removal of hard banji for the longer round. Had such leaf not been rejected the fresh weight yield would have obviously increased, but it does not follow that the dry weight outturn would have been proportionately increased. A point apt to be overlooked is that more refuse tea would have been produced. Considering also that the yield of the seven day round was 25% higher than that for the fourteen day round it is open to doubt whether the inclusion of the leaf in question would have resulted in a higher yield for the longer round.

Before examining the influence of coarse plucking from the manufacturing point of view it must be pointed out that in the experiment just referred to no significant difference was observed in the teas made. It has also been found in India (4) that there is no difference in quality between two leaves and a bud plucked above the fish leaf and two leaves and a bud plucked leaving a leaf above the fish leaf. Besides, it has been shown (5) that there is no statistical difference in the chemical composition between leaf from bushes plucked at weekly and fortnightly intervals. From these results it may be concluded that, so long as the physical composition of the pluck is the same, there is no connection between the age of a pluck and the quality of the tea. The maturity of the pluck exerts a marked influence only when leaf from a long round, that should normally be discarded, finds its way into the factory. Not only is such leaf tough and hardened but with it also goes the over-grown stalk that produces the so-called ' reds ' in tea.

The most serious problem arising from the manufacture of coarse leaf is without doubt the elimination of ' stalk '. It is of such magnitude that various machines are put on the market from time to time for ridding the tea of this undesirable feature. Yet none of these, to the writer's knowledge, has shown much promise and the extraction of stalk still goes on by hand, perhaps, aided of late by a new device employing the suction principle. It must be added that the cost of picking is an expensive item in any factory and has to be weighed against any saving in plucking costs likely to accrue from coarse plucking if overall profit is to be considered.

The next biggest effect is the marked increase in the outturn of the off-grades and waste tea. The percentage obtained is a true reflection of the standard of plucking and may be so high as to cause no little loss in the working of an estate. But, remarkable to say, the responsibility for this bad result is more often than not laid on manufacture, which is at the same time blamed for the production of open

leaf. It is no coincidence that in factories where coarse leaf is handled withers are invariably soft. The reason is not far to seek. If the tough leaf is to be withered at all withering must be prolonged but, if this is done, the tender shoots would suffer and so there is no alternative but to knock down the leaf as soon as the latter is ready. Thus a very uneven wither is obtained and it is no exaggeration to say that in such circumstances a considerable proportion of the leaf is in fact green. However carefully rolling may be carried out on such leaf it will never twist and flaky tea is bound to result. Quite apart from this effect the liquors will be light because sufficient pressure can not be applied without the showing up of too much stalk and fibre. To strike a balance between liquor and appearance under these conditions becomes a formidable task and manufacture, from being the straightforward process that it is, begins to be complicated. Infusions also become duller, a natural contribution from coarse leaf, and whatever is done is ineffectual in the end.

Experimenting with leaf similar in composition to that described in Table 2, significant differences were observed between the two fractions despite the fact that the fraction consisting of the harder leaves was not coarse in the real sense of the word. Table 4 gives the data showing the sort of effect produced.

Table 4. *Comparison of tender shoots and coarser leaves as taken for manufacture*

	Tender portion	Coarser portion
1. Percentage outturn of made tea to withered leaf	44	40
2. Percentage outturn of dhools	93	84
3. Percentage outturn of big bulk	7	16
4. Percentage outturn of grades	97	86
5. Percentage outturn of off grades, inclusive of broken mixed	2.5	7
6. Percentage outturn of waste tea, inclusive of pickings	0.5	7
7. Total percentage of off grades and waste tea	3	14
8. Percentage outturn of graded tea (off grades inclusive) to green leaf	18.3	17.4
9. Average valuation for the four main grades (B.O.P., Pekoe, Fannings and B.P.)	Rs. 1.82	Rs. 1.56

A glance at these figures is sufficient to show the benefits arising from a good standard of leaf. If the percentage of refuse tea is considered high when it exceeds 3% and that of broken mixed abnormal if more than 5%, the figures given above show what conditions can be on estates where a high proportion of coarse, hard leaf is plucked. Such teas, if graded on methodical lines, may produce even as much as 30% of off grades. It is not, therefore, hard to imagine the position when an estate is confronted with the problem of coarse plucking and has at the same time to produce certain predetermined outturns of grades. More often than not a set of conditions is imposed that in actual practice is unworkable if true grades are to be obtained. And the problem becomes more acute if the outturn of Broken Mixed Tea is limited to a ridiculously low figure that can only be associated with a high standard of plucking. The appearance of every grade, bad as it already is on account of stalk, fibre and open leaf, will then have to be further sacrificed in order to keep the outturn of off-grades as low as possible. All grades thus become diluted with leaf that should normally go as Broken Tea, Fannings, No. 2, Dust No. 2 and B. P. No. 2.

That a good class of leaf pays dividends is evident from the results of the experiment just described. The tasters, to whom these teas were submitted for report, were of the opinion that the teas from the coarser portion were very much inferior to the others in appearance, quality and infusion. In colour and strength

they were appreciably worse. The difference of 26 cents in valuation may not appear large but it must be pointed out that these teas were valued at a time when the market had declined by 60 cents in the short period of two weeks. Had market prices been on a higher level the difference in values would have been still greater and it is not difficult to visualise what the margin of preference would have been on a rising market at the height of the quality season when characteristics such as flavour and pungency are present and highly priced.

The results are worth reflecting upon by those who hold the view that it is more profitable to increase crop with the aid of coarse leaf rather than by selective plucking on shorter rounds. From what has been considered so far with regard to the influence of the length of a plucking round it has been shown that, for the same standard of fineness of flush, the reduction in crop for a longer round is so substantial that it does not offset the lowered cost of plucking. It would appear therefore, that the only practical advantage that could be gained from the lengthening of a plucking round is that leaf that should normally be rejected is included in the crop. From the figures given in Table 3 it will be seen that, even with the inclusion of broken back material, the total yield in the case of the longer round was less than the weight of the two-leaved shoots alone from the shorter round. Had some of the tender leaves not been broken back, but allowed to develop larger before being removed, a gain in crop would have resulted but whether this extra coarse leaf would have made up for the difference in yields between the shorter and longer rounds is difficult to say.

Assuming that under such conditions yields are the same, it is quite obvious that cost of production will be lower for the longer round but it must be remembered that the class of leaf so plucked would be of a lower standard than that obtained from the shorter round. In the present state of knowledge and absence of reliable data it would be rash to say which method would pay better. A fuller study is most desirable and indeed necessary if the economic aspect is to be considered but the fact remains that loss of crop is not likely to result from plucking at short intervals.

It is not the purpose of this article to weigh the relative merits of short and long plucking rounds. They have been brought into the discussion chiefly with reference to the part they play in the composition of crop and to the manner in which a longer round contributes to the production of coarse leaf. Of greater importance from the standpoint of manufacture, however, is the type of coarse leaf produced from feeble bushes and which is easily recognizable by its tough, leathery character and size. Such leaf is far coarser than the third leaf from a shoot from a long round and hardly withers. These old leaves are no doubt taken because there is little to pluck on the surface and the deeper the plucker's hands enter the bush the coarser becomes the pluck. The effect of such leaf on the made tea is too familiar to many to merit description.

Time was when it was the practice to pluck leaf that was young and soft. Former plucking systems can not, it is said, be adopted today because of the difficulty of getting pluckers to pluck to a certain standard. Can it not be said equally that one of the chief contributory causes of a poor class of leaf is a low yielding bush ? Given a bush that is vigorous, the plucker will have less temptation to search for leaf below the plucking level. Better leaf will thus be plucked and a higher yield obtained without stripping the bush and wasting energy. The answer to bad plucking undoubtedly is not so much more supervision in the field but more intensive cultivation.

Sufficient has been said of the overwhelming importance of plucking as a factor influencing the finished product and it only remains to add the viewpoint of a broker with twenty seven years' experience in the trade. The position cannot be summed up better than by quoting the late R. H. Horne's own words (6) on this question :—" The shorter route to better tea is essentially through the standard of plucking.....You can spend a lot of money on machinery or factories and you may, or you may not, make better tea, but if you improve your standard of plucking you can be confident of an improved product."

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DISTRIBUTION OF COPPER CONTAINING DUSTS

By

F. Haworth

As part of a comprehensive series of experiments designed to determine the usefulness of dusting with copper fungicides, as a means of controlling the blister blight disease of tea, an attempt was made, during July 1951, to assess the distribution of various proprietary dust formulations under steady wind conditions.

The site of the experiment was the tunnel on the Ceylon Government Railways' line (single track) at Talawakelle. This tunnel is some 680 feet long. During the experiments here described a fairly steady wind of about 4 m.p.h. blew through the tunnel from south to north. The Whirlwind dusting machine, which was used, made its own small contribution to this steady breeze.

Two pounds of each dust were blown through the dusting machine, the nozzle of which was horizontal and positioned at a height of 6 feet from the ground. The machine was placed some ten yards inside the tunnel to avoid possible wind eddies at the entrance.

Glass plates of uniform size were placed at intervals throughout the length of the tunnel directly in line with the nozzle of the machine. After the projection of the dust the tunnel was allowed to clear completely of dust before the glass plates were collected. The plates were then brought to the laboratory and the amount of copper on each plate was determined using the standard sodium diethyldithiocarbamate colorimetric method.

The following 13 dusts were tested :—

1	Universal Crop Protection Ltd.	—Cuprosana	2% Cu.	as oxychloride
2	Imperial Chemical Industries Ltd.	—Perelan	2% Cu.	„ cuprous oxide
3	„ „ „ „		2% Cu.	„ oxychloride
4	Colombo Commercial Co., Ltd.	—	2% Cu.	„ „
5	Robins	—	2% Cu.	„ „
6	Robins plus bentonite	—	2% Cu.	„ „
7	Universal Crop Protection Ltd.	—Cuprosana	4% Cu.	„ „
8	Imperial Chemical Industries Ltd.	—Perelan	4% Cu.	„ cuprous oxide
9	„ „ „ „	—	4% Cu.	„ oxychloride
10	Universal Crop Protection Ltd.	—Cuprosana	6% Cu.	„ „
11	Colombo Commercial Co., Ltd.	—	6% Cu.	„ „
12	Imperial Chemical Industries Ltd.	—Perelan	8% Cu.	„ cuprous oxide
13	„ „ „ „	—	8% Cu.	„ oxychloride

The total copper deposits on the plates, each of area 100 sq. cms., at various distances from the machine are shown in Table I.

Table I. *Copper deposits, in micrograms per plate, at different distances from the machine*

Distance from machine; feet	DUSTS												
	1	2	3	4	5	6	7	8	9	10	11	12	13
5	300	93	156	—	—	—	—	365	3451	35	132	1363	2797
10	466	288	1100	31	—	—	27	3847	1046	365	165	18780	9840
25	253	3500	1647	258	36	87	97	3801	8473	786	2571	23380	26270
50	660	994	614	538	257	240	270	1144	3145	205	961	4084	6760
75	239	515	212	186	266	370	277	497	1312	481	461	1198	2209
100	125	578	127	100	206	277	177	lost	406	212	281	234	2400
150	38	76	58	80	172	200	105	60	110	124	155	230	131
200	12	11	82	—	103	110	63	37	39	90	140	226	—
250	—	10	—	—	56	60	32	—	—	65	174	217	—
350	15	—	—	—	6	—	6	—	—	49	—	—	—
450	—	—	—	—	2	—	2	—	—	19	—	—	—
550	—	—	—	—	—	—	—	—	—	—	—	—	—

Discussion

The various dusts behaved differently on issuing from the machine. Formulations Nos. 2, 8, 9, 12 and 13 formed rather dense clouds which did not billow out sideways until they had travelled some 50 feet from the machine. This is considered to be the reason for the excessive deposits which these dusts gave on the plates close to the machine. In considering the figures it must be borne in mind that the copper contents of the dusts ranged from 2% to 8%.

The other dusts rapidly filled the whole width of the tunnel and advanced as clouds. An observer at the north end of the tunnel reported that with every formulation a considerable cloud of dust emerged from that end of the tunnel. Considering the values obtained for the copper deposits on the plates at between 250 and 550 feet from the machine, it will be seen that, except for dust No. 10, virtually no copper settled on the plates placed at 350 feet or more from the machine. Hence it may be concluded that the dust clouds which emerged from the north end of the tunnel were either devoid of copper or consisted of particles so fine that they did not settle under the prevailing wind conditions. Small but definite deposits of dust were visible on the plates at 350, 450 and 500 feet from the machine with all formulations and it would appear therefore that the very fine clouds of dust which emerged from the north end of the tunnel carried little or no copper with them. From other experiments, which will be reported in due course, it seems as if appreciable amounts of copper are necessary to protect young tea leaves against the blister blight fungus and the observation that only very small quantities of copper travel beyond 350 feet, even with the best formulations, may be of considerable importance. The absence of deposits on the plates close to the machine in the case of some dusts is not important since the nozzle of the machine was fixed in a horizontal position, which would not be the case in field practice. Even on those plates which showed deposits at 5 and 10 feet, the deposits were not even but consisted mainly of large spots, apparently due to aggregates and small lumps which fell out immediately on leaving the nozzle of the machine.

Figs. 1, 2 and 3 show, on a logarithmic scale, the distribution of copper with distance.

Conclusions

1. It would appear that, for application by the large drift duster type of machine, formulations Nos. 2, 8, 9, 12 and 13 are of little use since they do not spread out very readily and would probably lead to very heavy but localised deposits of fungicides.

2. The general limit of carry seems to be in the region of 250 feet. Only dust No. 10 can be considered to have given any appreciable deposit beyond this point and the extreme limit with this formulation was about 450 feet.

3. The apparent distance which a dust cloud travels in the field may be very misleading in considering the relative merits of the various formulations, for the chief concern is how far copper, in effective quantities, travels.

4. Since these experiments were carried out under conditions much more favourable than could normally be expected in the field it may be concluded that the probable effective range of the dusts now available, using normal drift dusting technique, is of the order of 200-250 feet. In the case of dust No. 10 the figure is probably about 350 feet.

These results refer to formulations of dusts supplied by the various manufacturers in early 1951.

Acknowledgments

This experiment was made possible through the co-operation of the General Manager of the Ceylon Government Railways. Thanks are also due to the District Engineer and Foreman Platelayer, Nanu Oya, for assistance in the actual operations.

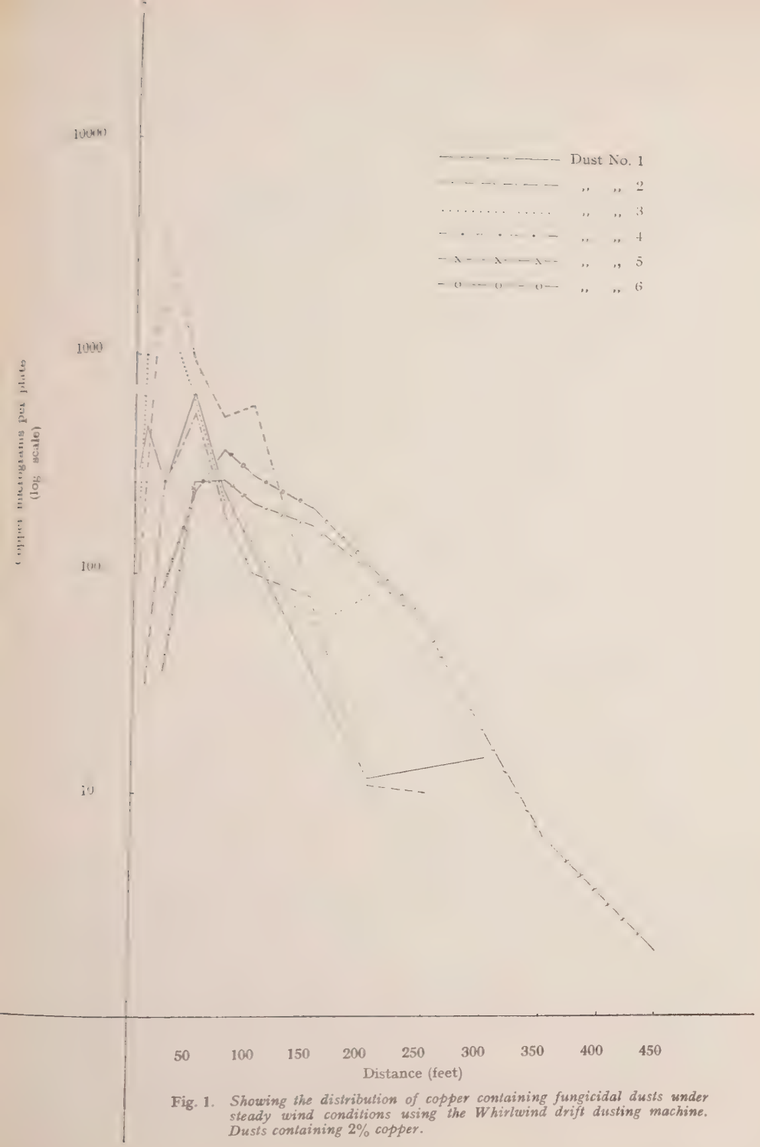

Fig. 1. *Showing the distribution of copper containing fungicidal dusts under steady wind conditions using the Whirlwind drift dusting machine. Dusts containing 2% copper.*

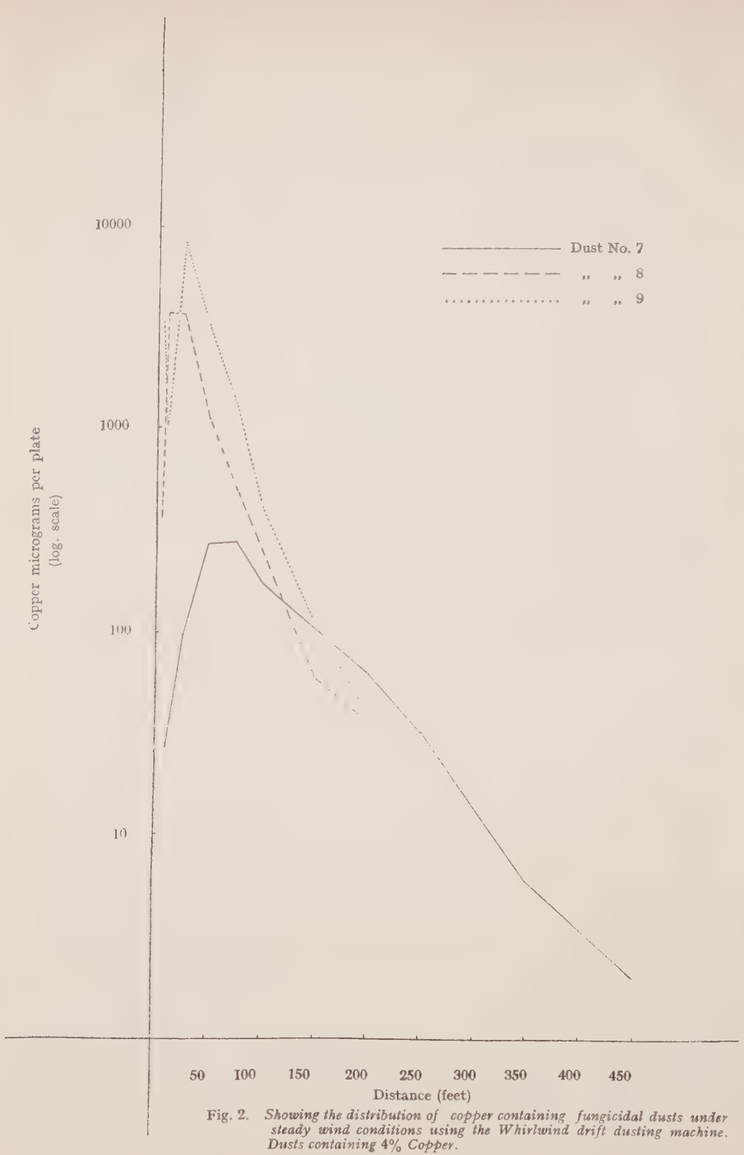

Fig. 2. *Showing the distribution of copper containing fungicidal dusts under steady wind conditions using the Whirlwind drift dusting machine. Dusts containing 4% Copper.*

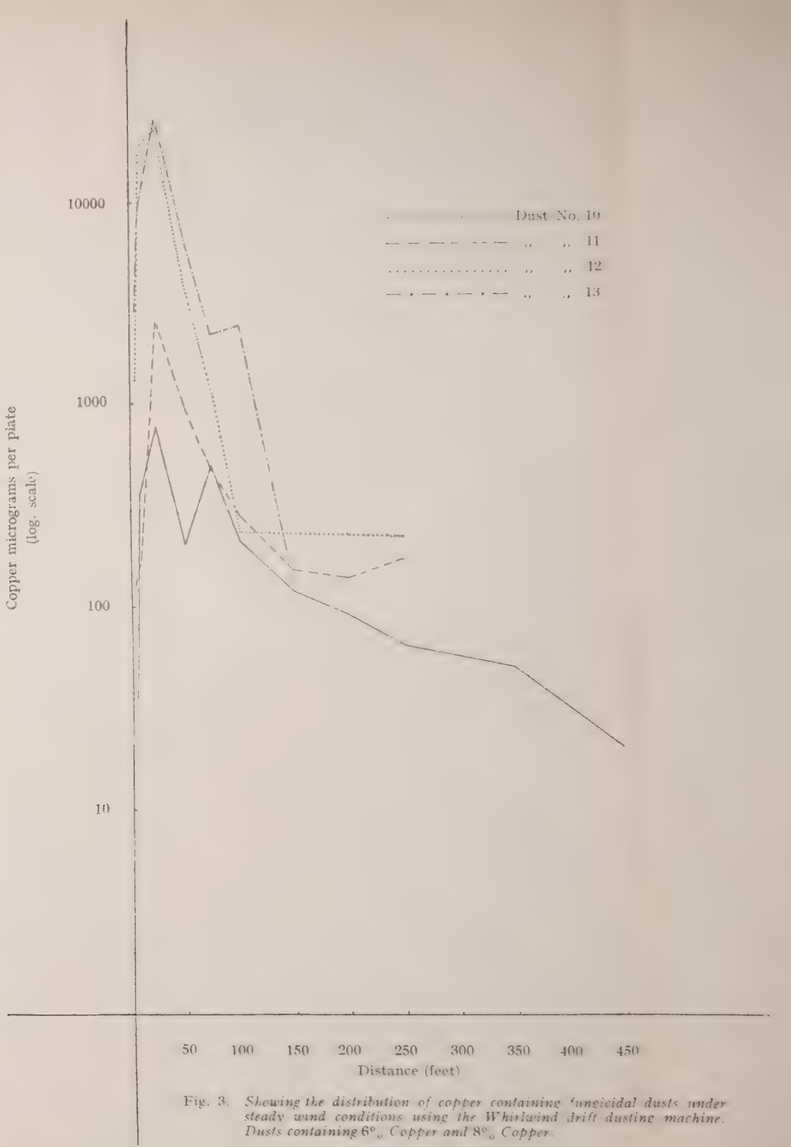

Fig. 3. *Showing the distribution of copper containing fungicidal dusts under steady wind conditions using the Whirlwind drift dusting machine. Dusts containing 6% Copper and 8% Copper.*

THE ENGINEERING DEPARTMENT

By

J. Landreth

The addition of an engineer to the staff of the Institute and the establishment of a suitably equipped workshop represents the first stage in the implementation of the recommendations contained in the "Report on Blister Blight Disease in Ceylon Tea Plantations", which was submitted to the Tea Controller in November, 1949, and subsequently accepted by the Government.

In accordance with the recommendations contained in this Report, the workshop provides all the necessary facilities for mechanical work in connection with the development of spraying and dusting machines. No facilities for the durability testing of commercial machines and materials are, however, available.

This department of the Institute was established in 1950. A temporary workshop was initially set up near the laboratory to enable test and modification work to be carried out to existing types of spraying equipment then available in Ceylon.

A new workshop has now been erected near the factory and, although small, is well equipped to deal with all classes of work on crop protection equipment and machinery maintenace.

A brief summary of the machines installed, all of which have individual electrical drives is as, follows :—

(1) "Harrison" Centre Lathe, arranged for surfacing, sliding, screw cutting milling, boring and grinding.

(2) "Myford" Wood-Turning Lathe, with attachments for wood or light metal turning, wood planing, sanding and sawing.

The above machines are of sufficient size to deal with tea roller cones up to 17" diameter.

(3) "Acorntools" High Speed Shaping Machine, on which a wide variety of operations can be performed, including the cutting of gear and ratchet teeth, key-ways, fillets, beads and grooves.

(4) "Pacera" Drilling Machine, with a spindle speed of from 80 —4,000 r.p.m. and capable of taking all drill sizes up to 3/4 inch.

(5) "Milford" Grinder, of the usual double-ended type, one wheel being arranged for wet grinding.

A wide variety of tools required for engineering work is kept in stock. Welding is carried out by the usual oxy-acetylene process.

The primary object of the Engineering Department is the development of crop protection equipment to suit conditions on Ceylon tea estates. Specifications of all types of spraying and dusting equipment, available in the United Kingdom, U.S.A. and the Continent, are carefully examined and any items which appear promising are obtained for trial purposes. Considerably more mechanisation on crop protection work will undoubtedly take place within the next few years.

As an illustration of the type of work going on, the construction of a water-carrier and knapsack charging unit, suitable for use with a tractor, which was recently completed, will be described. With this unit 200 gallons of fungicide can be taken direct to the area to be sprayed, thereby eliminating mixing and carrying of small quantities of fungicide. As the unit is completely self-contained, the tractor can be released for other work on the estate, as soon as the unit has been taken to the field to be sprayed.

The pipe lines of the pump are arranged as follows :—

Filling of Tank. Water can be drawn from a stream or pond and discharged directly into the tank, or the tank can be filled by means of a hose from the normal water supply. A two-way cock, fitted in the suction line, enables the pump to be used either for drawing water from a nearby supply or from the tank.

Mixing of Fungicide. Fungicide is added to the water in the tank and agitated by means of liquid bye-passed through the relief valve on the discharge side of the pump, which can be adjusted to operate at any pressure up to 200 lbs. per square inch. Chemical analysis reveals that this agitation is sufficient for the fungicide which we are at present using on St. Coombs, but a mechanical agitator may be necessary in the tank for some of the other fungicides at present on the the market. A 100 mesh filter is fitted in the suction line between the pump and the tank.

Charging knapsacks. Knapsacks can be charged at or near this unit, or a considerable distance away, by means of hoses connected to the pump delivery pipes. The pressure in the pipe lines is of course adjusted by means of the relief valve on the pump to by-pass the liquid back into the tank as soon as the knapsack has reached the desired pressure. Valves are fitted on the hoses at a point adjoining the connection to the knapsack and these must be closed before disconnecting the knapsacks.

We hope in due course, to modify this unit to charge simultaneously up to six knapsacks with liquid in under two minutes. A small compressor will also be incorporated for charging or topping up the knapsacks with air, driven from the same engine which operates the pump. There are several power spraying outfits manufactured abroad, which if suitably modified, could be used for this purpose ranging from 20 gallons capacity and upwards.

We hope, in the near future, and as time permits, to co-operate with the Technologist in the many problems associated with the manufacture of tea. Apart from work on crop protection equipment, the staff of this department has been kept occupied on repair, maintenence and alteration work throughout the Institute.

THE LOW-COUNTRY SUB-STATION.

AN ACCOUNT OF DEVELOPMENTS TO-DATE.

By

T. E. Walter

Preliminary

The idea of establishing a Low-country Sub-Station of the Tea Research Institute, to deal with the particular problems of low-country tea on the spot, originated in 1941 from the Southern Province Planters' Association. It was also subsequently put forward at various times by the Sabaragamuwa Planters' Association and the Morawak Korale Planters' Association. Owing to the war, however, the matter was held in abeyance till 1946, when a conference was held at Ratnapura attended by delegates from all the low-country Planters' Associations. At this meeting the question of the locality in which the proposed sub-station should be established was fully discussed and, after the claims of several districts had been considered, it was decided that N. E. Kalutara was the most suitable, since it was representative of the low-country tea growing districts and easily accessible to all. The various lines along which research should be undertaken were also discussed, and it was decided that, in view of the general decline of low-country tea and the probable necessity for replanting large acreages, experiments with vegetative propagation should receive first priority.

The Board of the Tea Research Institute of Ceylon subsequently agreed to these proposals, the necessary funds were set aside, and in November 1949 I was appointed to take charge of the proposed station. A sub-committee of three members of the Board—with co-opted members from each of the low-country District Planters' Associations—was also appointed to be responsible for the establishment and development of the station.

Nivitigalakele

(1) **Transfer Arrangements.**—In January 1950 the Director of the Tea Research Institute, with members of the staff, inspected several estates in the Matugama area that were up for sale. It was also learned during this visit that there was a possibility that part of Nivitigalakele (a sub-station of the Rubber Research Scheme) might be made available to the Tea Research Institute—this estate having the additional advantages of being near the Rubber Research Scheme and being free of root diseases.

The question of the transfer of part or all of this estate to the Tea Research Institute was subsequently fully discussed by the respective Boards and a draft agreement prepared covering the transfer of the whole estate over a period of 15 years, with payment in instalments. This arrangement was naturally subject to there being no difficulty in the transfer of the Nivitigalakele lease.

(2) **Preparation of land for nursery and multiplication plots.**—In view of the urgency of establishing a nursery without further delay it was decided to go ahead without waiting for the formal ratification of the transfer agreement. A nursery site was therefore prepared under the supervision of my assistant, Mr. F. P. Jayawardana, and the selected clonal material offered by various low-country estates was collected and planted in July 1950 ; this amounted to some 5,000 cuttings (3,000 fresh and 2,000 rooted or callused) from over 100 clones—a most generous and valuable contribution from the five estates concerned.

Subsequently about two acres were cleared for multiplication plots and about 1000 of the biggest plants were put out in the field during the north-east monsoon, while detailed plans were made for the estate work to be done during 1951.

(3) **Termination of the Nivitigalakele project.**—During 1950 there was a growing feeling that the experimental rubber on Nivitigalakele was still capable of providing useful information. Accordingly, early in 1951, the proposed transfer arrangements were re-examined by the Board of the Rubber Research Scheme, who reluctantly came to the conclusion that, much as they would like to assist us, it would be unwise for them to agree to hand over any part of Nivitigalakele to the Tea Research Institute for the present. Furthermore, as a consequence of the expansion in the research staff of the Rubber Research Scheme, the Nivitigalakele bungalow was likely to be urgently needed for staff housing in the immediate future. These decisions, although somewhat disappointing, came as no great surprise to me and I accordingly arranged both to vacate the Nivitigalakele bungalow and remove our plants from the estate by the end of June.

Future Plans

(1) **Pembroke Bungalow.**—Before leaving Nivitigalakele I was extremely fortunate in being able to find at very short notice a large vacant bungalow, which appeared to be eminently suitable for my new headquarters, in the district. As a result the Tea Research Institute's Board has purchased the bungalow on Pembroke Estate, which is situated about four miles out of Kalutara on the Matugama road, and extensive repairs to the building are now in progress.* There seems to be little prospect at the moment of acquiring any part of Pembroke Estate itself, but part of the small area available round the bungalow is beingpreparedas a demonstration plot for all available types of bush green manures and cover crops.

** These have now been completed and Mr. Walter is already in residence. The postal address of the T.R.I. Low-country Sub-Station is Pembroke Bungalow, Bombuwala.—Ed.*

(2) **Multiplication plots.**—The Manager of Vogan Estate (Mr. J. D. Farquharson) was most helpful and co-operative in our predicament over the clonal material and very kindly agreed to let us transfer all our plants to his cleared land. A further 2000 clonal plants from 40 selected clones (1500 of which were rooted) were collected in time for June planting and a small nursery adjacent to these plots also prepared ; collection of more clonal material as offered is still continuing. A small area on Vogan has also been planted up with seed-at-stake for comparison purposes.

Negotiations are now in progress regarding the proposed lease of ten acres of this estate to the Tea Research Institute—in two blocks of four acres and six acres. The first of these has already been cleared and the second consists of old rubber due to be cleared in any case in 1953. If this arrangement goes through, the intention is to plant up these blocks with material from the best of the mother bushes.

(3) **Experiments on old tea on Vogan Estate.**—The Manager of Vogan Estate was also kind enough to allow us facilities for carrying out field experiments on old tea, and a long-term manurial experiment has been laid down, as well as a short term minor element experiment.

(4) Further plans for planting up other small blocks with selected clonal material are at this stage rather nebulous. It is hoped, however, that we shall be able to find a small block of suitable land on a tea estate in the Ratnapura district for V. P. experiments under the somewhat different climatic conditions there ; this would, of course, be dependent on the estate concerned being able to supply the necessary labour and supervision. Extensive enquiries have already been made regarding a similar scheme on another estate in the Kalutara district, and one proposal shows sufficient promise to warrant further consideration. We shall not, however, be in a position to plant up these blocks until 1953, by which time adequate planting material should be available from the Vogan multiplication plots.

NOTICES.

The Institute's Laboratories and Offices are situated at St. Coombs, Talawakelle, and all applications and enquiries should be addressed to the Director, Tea Research Institute, St. Coombs, Talawakelle.

Specimens and other consignments sent by rail should be forwarded to Talawakelle Station c/o Messrs. M. Y. Hemachandra & Co., Forwarding Agents. *Carriage should be pre-paid.*

Visitors' Days The *second* and *last* Wednesdays in each month have been set aside as Visitors' Days, at St. Coombs Estate and also at the T. R. I. Sub-Station, Gonakelle Estate, Passara, when it is hoped anyone interested will visit the Stations.

Rules for the Occupation of St. Coombs Guest House

(1) The Guest House is normally intended for the use of persons visiting the Institute and St. Coombs Estate on business. Children can in no circumstances be accommodated.

(2) Permission to occupy a room for the night must be obtained from the Director in writing and, unless sufficient notice be given, accommodation cannot be guaranteed.

(3) All visitors must sign the Visitors' Book on arrival.

(4) A bedroom may not be occupied for more than one night if required by another visitor. This shall not apply to Members of the Board or of Committees meeting at St. Coombs who shall also be entitled to priority in the allocation of accommodation when on official business.

(5) Complaints or suggestions shall be entered in the book provided for the purpose and not made to the Guest House Staff. All payments due for services rendered shall be made in *cash* to the Guest House Keeper and a receipt obtained from him on the official form. The scale of approved charges is posted in the building. The Guest House Keeper is forbidden to give credit or to accept cheques.

(6) All breakages will be charged for at cost price.